DISTINGUISHING BETWEEN LYNX SPIDERS (ARANEAE: OXYOPIDAE) RELEVANT TO IPM IN COTTON IN THE NAMOI VALLEY, NEW SOUTH WALES

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Abstract

Characters are presented to enable identification of three similar species of lynx spiders (*Oxyopes molarius* L. Koch, *Oxyopes amoenus* L. Koch and *Oxyopes gracilipes* (White)) commonly found in cotton in northern New South Wales. The aim is to enable non-specialists to readily distinguish between these species so that they can be better incorporated within an Integrated Pest Management (IPM) framework.

Introduction

The advent of transgenic Bt cotton has had a major impact on the cotton industry by largely controlling lepidopteran pests, with little effect on the rest of the insect community (Whitehouse *et al.* 2005, Hagerty *et al.* 2005). This has made cotton more amenable to Integrated Pest Management (IPM) strategies (Fitt and Wilson 2000, Deutscher *et al.* 2005) and has led to a drop in the amount of insecticide used on cotton (Fitt 2004), which has had major benefits to the community.

However, one consequence of reduced insecticide use is that minor pests, that were once controlled by sprays for *Helicoverpa* Hardwick spp. (Lepidoptera: Noctuidae), have become major pests in cotton. One such group of pests are the green and brown mirids *Creontiades dilutus* (Stål) and *Creontiades pacificus* (Stål) (Hemiptera: Miridae) respectively. In Bollgard®II cotton, the need to control mirids and other sucking pests, such as the green vegetable bug *Nezara viridula* (Linnaeus) (Hemiptera: Pentatomidae), tends to undermine the gains in reduced insecticide use that came with Bt cotton. This is because the broad-spectrum insecticides used to control these pests could disrupt the beneficial arthropods and increase the risk of secondary pest outbreaks such as mites and aphids.

One means of controlling mirids without resorting to insecticide spray, is to maintain or increase the numbers of predators in cotton that are likely to attack them. One of the main groups of predators in cotton are spiders, which make up 50% of the beneficial arthropod community in unsprayed cotton crops in Australia (Bishop and Blood 1981). Although little is known about the exact role that spiders play in the management of pests in cotton, it is known that lynx spiders (Oxyopidae) are mirid predators (Bishop and Blood 1981, Young and Lockley 1986, Nyffeler *et al.* 1992). They are also the most abundant family of spiders in Australian cotton (Whitehouse *et al.* in press). The dominance of lynx spiders in Australian cotton fields indicates that this family could be effective against mirids.

In order to utilize specific oxyopid species within an IPM framework for the control of pests, there is a need to be able to distinguish between species. However, as is the case with many Australian spider families, there are no recent revisions of the Oxyopidae. The last published work was a catalogue (Roewer 1954) that listed 14 Australian species, 12 of which were in the genus *Oxyopes* Latreille. Since then only a few papers have been published. Grimshaw (1989) reported the first record of another genus, *Hamataliwa* Keyserling, in Australia. Vink and Sirvid (1998, 2000) provided reports on *O. gracilipes* (White), but identification of specimens from their work was not possible. Townsend *et al.* (2001) provided good descriptions of some Australian Oxyopidae, but from that work it is still not possible to confidently identify a specimen at hand. To date there is only one revisional work on Australian Oxyopidae, an unpublished thesis by Grimshaw (1991).

The aim of this paper is to provide simple tools to differentiate between the three species of Oxyopidae commonly found in cotton in the Namoi Valley of northern New South Wales. By aiding species identification of these spiders, we hope to facilitate their use within an IPM framework for the control of insect pests.

Materials and methods

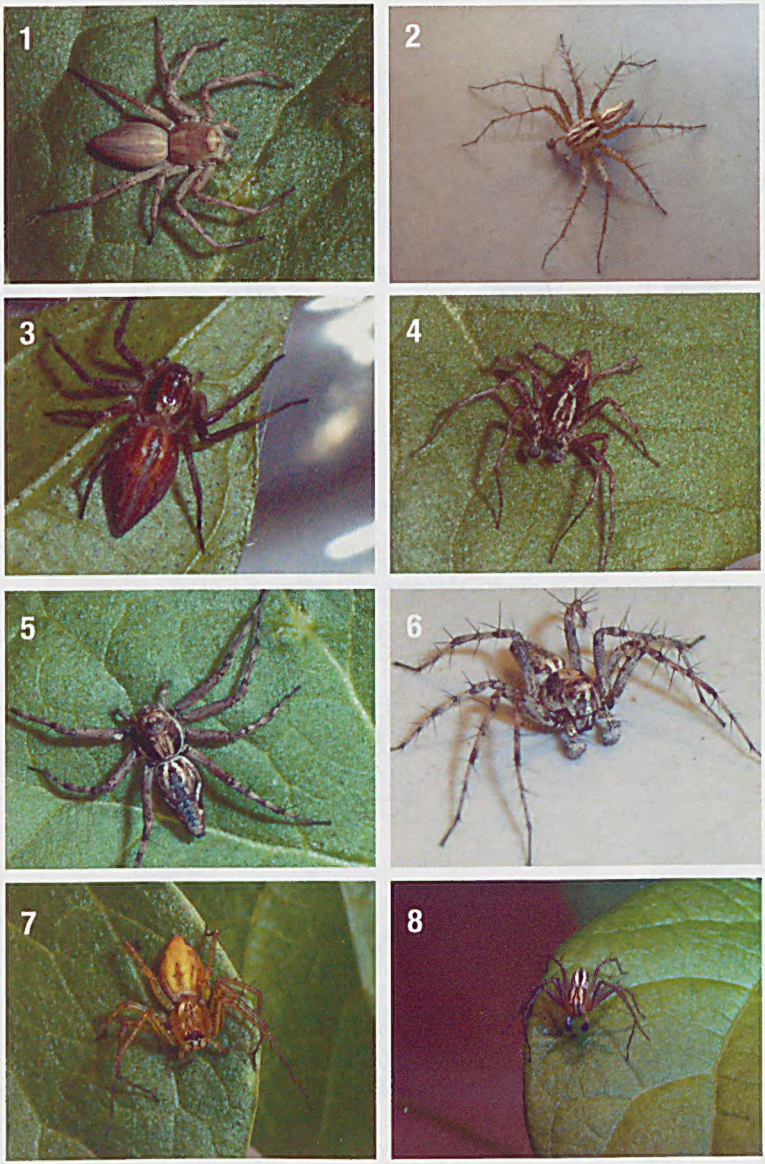
Oxyopidae were collected using beatsheets (Mansfield *et al.* 2006) or visual searches throughout cotton growing seasons at the Australian Cotton Research Institute (30°11'S, 149°33'E) at Narrabri, NSW. During the 2006/07 cotton growing season, samples of 10 beatsheets on 10 sampling dates were taken throughout the season. All lynx spiders in the samples were sorted to species. Three species were found (Figs 1-8): *Oxyopes molarius* L. Koch ('plain brown lynx'), *Oxyopes amoenus* L. Koch ('banded lynx') and *Oxyopes gracilipes* (White) ('stocking lynx').

Adult specimens were identified using the key to species in Grimshaw (1991) and through comparisons with specimens held at the Queensland Museum, which had been verified by comparison with type material held in Hamburg, Germany. Voucher specimens of each species are lodged with the Queensland Museum (female *O. molarius*: QMS 83346; male *O. molarius*: QMS 83278; female *O. amoenus*: QMS 83277; male *O. amoenus*: QMS 83276; female *O. gracilipes*: QMS 83347; male *O. gracilipes*: QMS 83279).

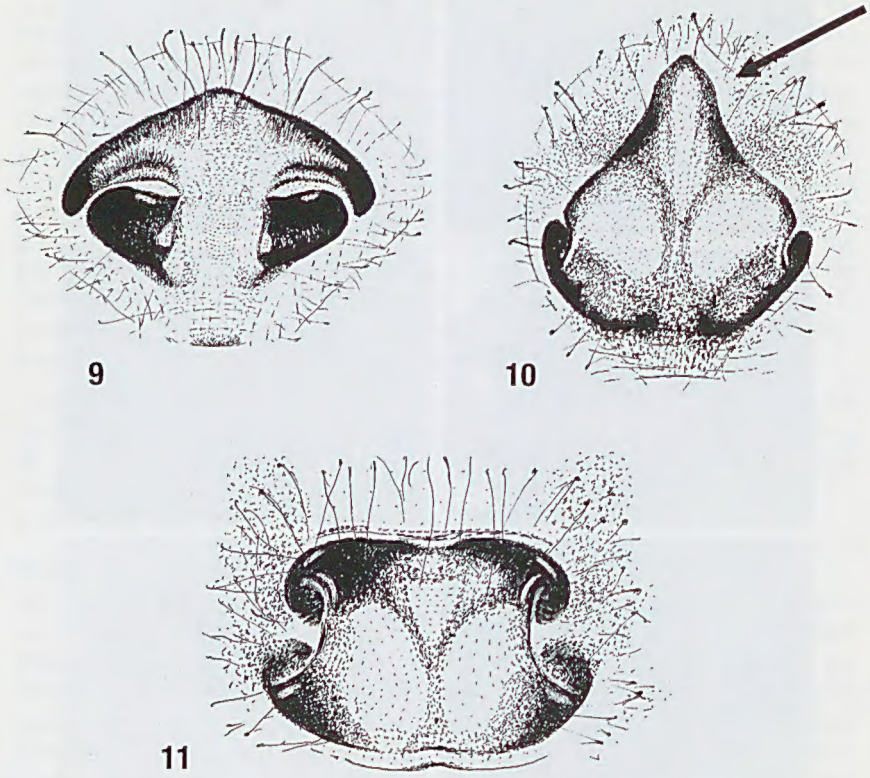
Results

Female genitalia

The external genitalia of females of the three species are easy to differentiate (Figs 9-11). *O. molarius* has a median septum with a broad longitudinal process, while *O. amoenus* has a median septum with a narrow and attenuate longitudinal process. *O. gracilipes* has a broad median septum with no processes.



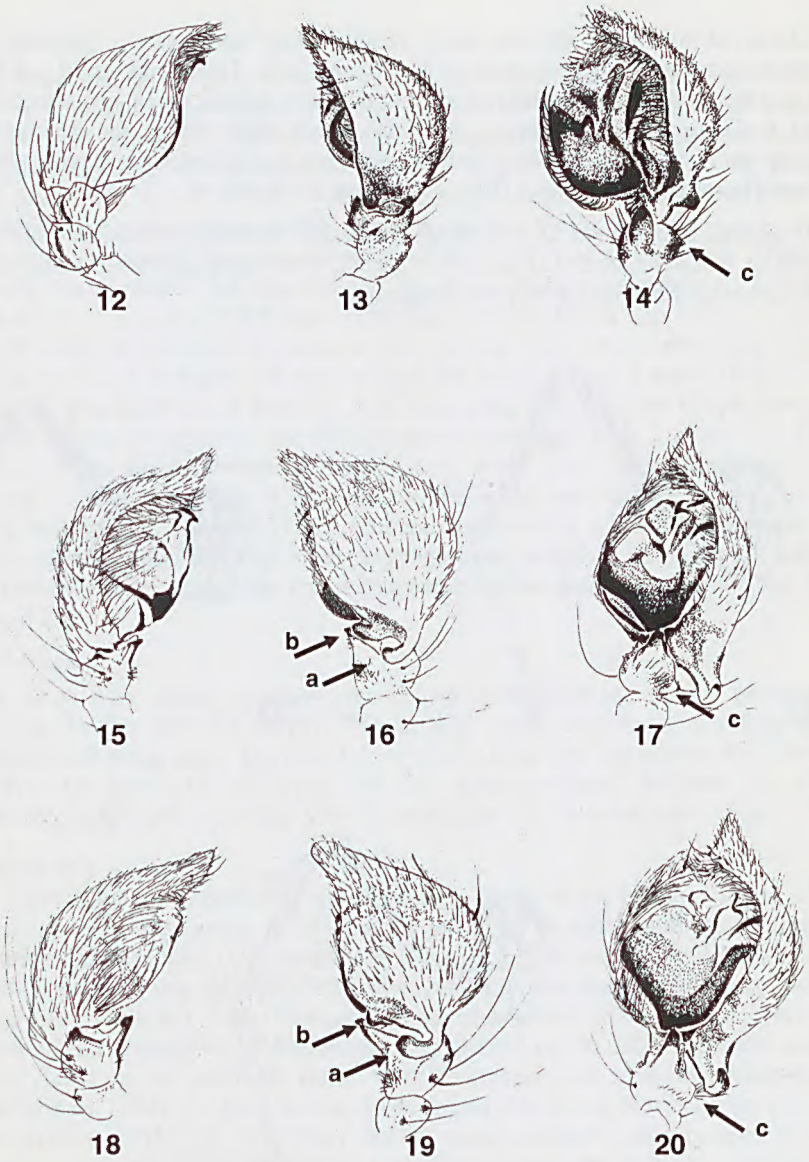
Figs 1-8. Photographs of female (left) and male (right) *Oxyopes* spp. commonly found in cotton in the Lower Namoi Valley, NSW. (1-2): *O. molarius* (pale morph); (3-4): *O. molarius* (dark morph); (5-6): *O. amoenus*; (7-8): *O. gracilipes*. Note the bands on the legs of *O. amoenus* (Figs 5-6), and the longitudinal stripe on the femur of *O. gracilipes* (Figs 7-8). The dark morph in *O. molarius* can be produced by the loss of the light hair covering from the pale morph.



Figs 9-11. Epigyna of *O. molarius* (9), *O. amoenus* (10) and *O. gracilipes* (11), showing differences in the median septum, which extends anteriorly in *O. amoenus* (arrowed).

Male genitalia

Distinguishing between the palps of *O. gracilipes* and that of the other two species is relatively easy; *O. gracilipes* has a small, triangular cymbial apophysis (Fig. 13) instead of the large, distinctively hooked cymbial apophysis of *O. amoenus* and *O. molarius* (Figs 16 and 19 respectively, arrow a). However, distinguishing between males of *O. molarius* and *O. amoenus* is difficult. The only differences we found between the palps of these two species were the shape of the hook (Figs 16 and 19, arrow a; the hook is longer and more curved in *O. molarius*) and the shape of a second cymbial apophysis, which is a small mound in *O. molarius* and bears a thickened proximal border resembling a hook in *O. amoenus* (Figs 16 and 19, arrow b).



Figs 12-20. Male palps of *O. gracilipes* (12: lateral; 13: dorsal; 14: ventral view), *O. amoenus* (15: lateral; 16: dorsal; 17: ventral view) and *O. molarius* (18: lateral; 19: dorsal; 20: ventral view), showing the hooked cymbial apophysis (arrow a) in *O. molarius* and *O. amoenus*. In *O. molarius* the hook is longer and more curved, while in *O. amoenus* a second cymbial apophysis (arrow b) shows a thickened proximal boarder resembling a hook. Arrow c = retrolateral tibial apophysis.

Males of all three species have ventral tibial apophyses (opposite the thickened border: arrow b in Figs 16 and 19). Townsend *et al.* (2001) identified a retrolateral tibial apophysis that was present on *O. gracilipes* and *O. molarius* but missing on *O. amoenus*. In our observations, the structure is clear on *O. gracilipes*, while both *O. molarius* and *O. amoenus* have a slight retrolateral tibial apophysis (Figs 14, 17 and 20, arrow c).

In general appearance, *O. gracilipes* is sexually dimorphic while *O. molarius* and *O. amoenus* are not (Figs 2, 4, 6 and 8). The cephalothorax of some male *O. gracilipes* had an underlying orange hue.

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Figs 21-23. Markings on leg I of *O. molarius* (21), *O. amoenus* (22) and *O. gracilipes* (23). *O. gracilipes* has is single, sharp black stripe; *O. molarius* has either no stripe or one or two broader and more diffuse stripes; *O. amoenus* has no longitudinal stripes but has transverse bands around the patellae and tibiae (arrowed).

Legs

All three species are very variable in their abdominal pattern due to abrasion of the coloured scales; hence it is very difficult to distinguish between them in the field, especially between juveniles. In general, *O. gracilipes* has more slender legs and is slightly smaller (body length, male: mean = 4.5 mm, std.dev. = 0.3, n = 25; female: mean = 5.9 mm, std.dev. = 0.8, n = 25) than either *O. molarius* (body length, male: mean = 6.5 mm, std.dev. = 0.9, n = 24; female: mean = 8.3 mm, std.dev. = 1.4, n = 31) or *O. amoenus* (body length, male: mean = 6.4 mm, std.dev. = 1.2, n = 26; female: mean = 7.8 mm, std.dev. = 1.3, n = 26) but this difference is often difficult to observe. The most useful distinguishing characteristic of both adults and juveniles of the three species is probably the markings on the femur of legs I and II (Figs 21-23). *O. gracilipes* has a distinct, thin, dark longitudinal stripe on prolateral femur 1 (like the seam on old-fashioned silk stockings: Figs 7, 8 and 23). *O. molarius* has more variable leg markings; in some there are no markings on femur 1, while in others it has one or two broad and diffuse longitudinal stripes (Figs 1, 2, 3, 4 and 21). *O. amoenus* is generally a much darker spider than the other two; although it has no longitudinal stripe on its femur 1 it may have dark patches and it has transverse bands on the patella and tibia (Figs 5, 6 and 22).

Distribution

All three lynx spider species were found throughout the cotton growing season. In the 2006/07 survey, 766 spiders were collected (including 62 adults) and these were identified to species using the characters described above. Of these, *O. molarius* was the most common, followed by *O. amoenus*. During this drought year *O. gracilipes* was relatively rare (Fig. 24).

Discussion

We identified three species of lynx spiders in cotton in the Namoi Valley. All three species are found in all cotton growing regions southwards from southern Queensland (Grimshaw 1991, Vink and Sirvid 2000, Whitehouse and Grimshaw, unpublished data). *Oxyopes molarius* and *O. amoenus* have also been collected from Townsville and Emerald in northern and central Queensland respectively (Whitehouse and Grimshaw, unpublished data) and both occur as far north as Cape York Peninsula and in South Australia (Grimshaw 1991). *O. amoenus* has been found also in the Northern Territory (Grimshaw 1991). *O. gracilipes* has a more southerly distribution, with specimens found in SE Queensland and coastal regions of NSW, Victoria, South Australia and SW Western Australia (Grimshaw 1991). Thus, although this study focuses on the Namoi Valley, the species described are relevant to most cotton growing regions in Australia.

Although spiders are one of the largest and most common invertebrate groups in cotton, they are often ignored as agents in pest management. This is largely because most work to date has focused on insects rather than spiders.

Consequently, the insect fauna in crops is well documented and much is known about insect responses to crop conditions. This information has generated models on insect economic thresholds and the effect of beneficial insects on these thresholds (*e.g.* 'the predator to pest ratio': Mensah 2002, Deutscher *et al.* 2005). Because spiders are quite distinct from insects, models extrapolated from insect work may be not suitable for spiders. In addition, spider species in cotton have not been well documented, making it difficult for crop scouts to identify spiders beyond family level. Improving spider identification will enable information specific to key spider species to be incorporated into the management of pest species.

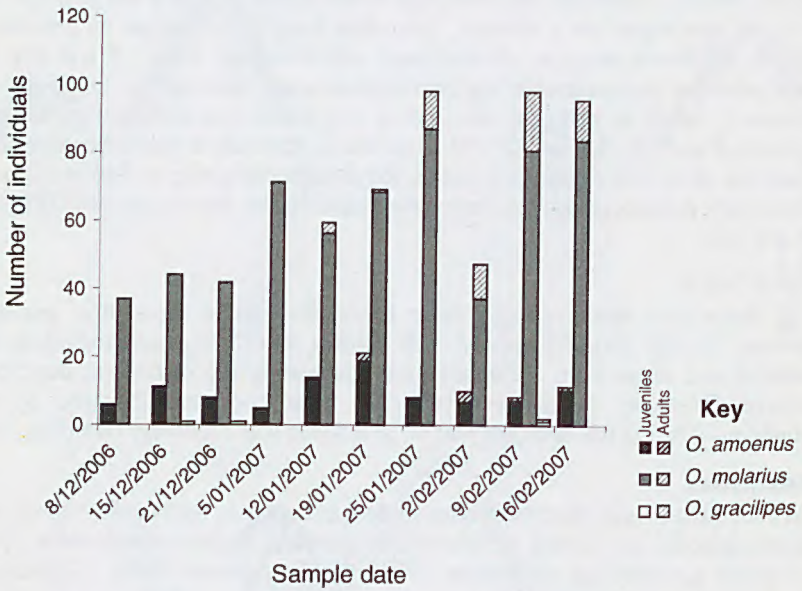

Fig. 24. Number of lynx spiders caught in beatsheets in cotton during the 2006/07 season. In this drought year, *O. molarius* was the most common, followed by *O. amoenus*; *O. gracilipes* was rare.

As mirids and other secondary pests become more of a problem in cotton, it is important that key predators are accurately identified. Particular species of lynx spiders are known to attack mirids. For example, the striped lynx spider, *Oxyopes salticus* Hentz, is responsible for 15-18% of the daily mortality of the cotton fleahopper *Pseudatomoscelis seriatus* (Reuter) (Hemiptera: Miridae) in Texan cotton fields (Nyffeler *et al.* 1992) and 31% of all striped lynx spiders in cotton had consumed immature fleahoppers (Breene *et al.*

1989). In Australia, Bishop and Blood (1981) identified *O. gracilipes* (as *Oxyopes mundulus* L. Koch) as an important predator of *Helicoverpa* spp larvae in Australian cotton crops. In our own work we found that female *O. molarius* were particularly good at attacking adult mirids, while *O. gracilipes* was not as effective (Whitehouse and Barnes, unpublished data). To make use of this information and develop it further, it is important to be able to easily distinguish between these two very similar species.

Acknowledgements

We thank Judy Nobilo (CSIRO Entomology) for the illustrations and photographs and for maintaining the spiders in the laboratory, and Rob Raven (Queensland Museum) for comments on the manuscript and access to collections. This research was funded by the Cotton Research and Development Corporation (project number: 3.2.19 AC), and the Cotton Catchment Communities Cooperative Research Centre (project number: 1.01.01).

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